Role of biomedical knowledge in learning visual diagnosis

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Role of biomedical knowledge in learning visual diagnosis

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Abstract

Abstract:
In the medical profession, biomedical knowledge (i.e., facts about (ab)normal functioning of the human body) forms the basis for expertise. This study investigated the role of biomedical knowledge in learning to examine information-dense, dynamic medical images, namely ultrasound fetal images. For this purpose, 33 medical students with biomedical knowledge background were compared to 44 human-movement science students with a knowledge background in the biomechanics of human movement. All students learned to examine the ultrasound videos in a computer-based learning environment where distinguishing two types of fetal movement patterns were taught: isolated movements and general movements, which are both complex movement patterns of several body parts. Results showed that on the total testing score, irrespective of the knowledge background, isolated movements were more difficult to determine than general ones. To understand this finding, analyses on subscales of test performance were calculated. Again, no main effect of knowledge background was found. A main effect of movement type revealed that detecting which body parts are involved in isolated movements is slightly easier than for general movements. Describing movement speed and amplitude, however, is more difficult for isolated movements than general movements. Moreover, an interaction effect showed that medical students can draw better conclusions on the (ab)normality of the movement for general movements than for isolated movements, while for the human-movement science students it is the reverse. These findings indicate that while biomedical knowledge enables students to learn to draw conclusions from complex movement patterns, knowledge of the biomechanics of human movement allows better judgment of simpler, isolated movements. Hence, it may be worth to consider both forms of knowledge in the medical curriculum.

Extended summary (1000 words max.)

Extended summary: type text in the box below

Biomedical knowledge (i.e., knowledge of the human body and its functioning and dysfunctioning) is the foundation for medical expertise and plays a crucial role in the medical profession (Boshuizen & Schmidt, 1992). Hence, medical education usually begins with the acquisition of large amounts of factual knowledge. Later, this knowledge must be applied in diagnosing diseases in patients. This diagnosis is based on patient data in the form of texts, graphs, or medical images. Thanks to technical developments, medical images are increasingly being used. Ultrasound, for example, has become a core tool for examining unborn children (i.e., fetuses). In particular, specific movement patterns have been found to indicate neurological (ab)normal fetal development (De Vries, Visser, & Prechtl, 1986). The question is, whether knowledge of fetal disease and normal behavior provides a good enough basis to learn to examine dynamic ultrasound images for movement patterns. An alternative knowledge-base might be knowledge of human movements in general. This study compared students with two different backgrounds, namely medical students (MS) with biomedical knowledge of neurological diseases and human-movement science students (HMS) with knowledge of the biomechanics of human movement, in order to investigate the role of knowledge background on learning to examine fetal movement-patterns. As this is a highly visual domain, not only the final outcome decision of this examination (here: *conclusion* on the (ab)normality of the movement) was investigated, but also two main underlying perceptual and cognitive processes leading to this decision, namely *detection* of involved body parts and *description* of motion in terms of speed and amplitude (cf. Jarodzka, Boshuizen, & Kirschner, 2012).

Methods

Participants and Design

Participants in the study were 73 individuals (*M*=3.94 (*SD*=1.19) years, 30 females) with two different study backgrounds, namely MS (N=33) and HMS(N=40).

Material and Procedure

Participants used an individual, computer-based learning and testing environment on the topic of fetal movements, which lasted 75 minutes. In the learning phase, students studied instructional videos on movements of isolated body parts and complex movement patterns involving several body parts (i.e., general movements), their description in terms of speed and amplitude, and their (ab)normality. In the testing phase, students viewed three new videos from which they had to *detect* which body parts were involved in the movement, *describe* its/their speed and amplitude, and draw a *conclusion* as to whether the movement was normal or abnormal.

Results

Data were analyzed on two levels, namely total score on each task and scores across the three question categories.

Analysis on Task Level

A repeated-measures ANOVA with 'field of study' (MS vs. HMS) as between-subject factor and 'movement type' (general vs. isolated) as dependent variable showed that the general movement (M=68.11%; SD=17.86) is easier to determine than isolated movement (M=52.88%; SD=24.12; $F(1, 71)=21.67$, $p<.01$). Neither an effect of field of study ($F<1$), nor an interaction was found ($F(1, 71)=2.62$, $p>.10$).

Analysis on Question Level

A repeated-measures MANOVA with 'field of study' (MS vs. HMS) as between-subject factor, 'task type' (general movement vs. isolated movement) as within-subject factor and performance on the three questions as dependent variables showed no main effect of 'field of study' ($F(3, 69)=2.14$, $p>.10$), though a main effect of 'movement type' was found ($F(3, 69)=30.66$, $p<.01$). Univariate tests revealed that detection of isolated movements (M=84.93%; SD=30.83) was marginally easier than general movements (M=77.28%; SD=14.15, $F(1, 71)=3.65$, $p=.06$), while description of isolated movements (M=21.23%; SD=35.28) was significantly more difficult than description of general movements (M=67.12%; SD=23.89, $F(1, 71)=84.18$, $p<.01$). No difference was found on drawing conclusions from both tasks, (M_{IM}=52.05%; SD_{IM}=50.30; M_{GM}=52.74%; SD_{GM}=35.25; $F<1$). Moreover, a significant interaction between 'task type' and 'field of study' was found $F(3, 69)=9.03$, $p<.01$. Univariate tests revealed that neither an effect on detection nor on description was found (both $F<1$), but rather that this interaction was due to an effect of drawing conclusions from the movement, $F(1, 71)=24.11$, $p<.01$. This effect showed that MS draw more correct conclusions from general movements than from isolated movements (M_{GM}=63.64%; SD_{GM}=31.31; M_{IM}=27.27%; SD_{IM}=45.23), while the opposite is true for HMS (M_{GM}=43.75%; SD_{GM}=36.14; M_{IM}=72.50%; SD_{IM}=45.22).

Discussion

This study investigated the influence of different knowledge backgrounds on learning to examine fetal movements. Surprisingly, results showed that irrespective of study background students' overall score was worse on determining isolated movements than general ones, even though general movements involve complex movement patterns of several body parts. Students possibly paid more attention to the general movements when studying, underestimating the complexity of isolated movements. To better understand these results, further analyses were conducted at question level. These analyses revealed that *detecting* body parts of isolated movements tends to be easier than of general movements. This is not surprising as the latter involves several body parts; hence, it is easy to miss one of these, while for the former only one body part has to be detected. More interesting, it is easier to *describe* the speed and amplitude of general movements than of isolated ones. Furthermore, an interaction was found on the *conclusions* drawn. While it was easier for MS to draw conclusions on general movements, HMS draw better conclusions on isolated movements and vice versa. This might be because HMS lack the biomedical knowledge needed to assess complex behavioral patterns such as general movements, while they can more easily learn to assess simpler behavioral patterns such as isolated movements. MS possess biomedical knowledge and thus, may be better able to deal with complex movement patterns. An unexpected finding was that MS fail in diagnosing isolated movements (only 30% correctness rate). It may be that such movements elicit an error in their probably long chain of reasoning from biomedical knowledge. Further research should investigate, where this error occurs. In sum, we can conclude that biomedical knowledge may not be sufficient to learn to carry out visual diagnoses. Biomechanical knowledge of human movements seems to be important too. Hence, it may be worth considering including both forms of knowledge in the medical curriculum.

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Keywords: insert 3-5 keywords below

Medical education, visual diagnosis, biomedical knowledge, fetal images, dynamic images